LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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Cold Weather and Low Temperature Lubrication

The Essential Factors in the Selection and Usage of Industrial Lubricants

THE advent of cold weather every year will most surely bring about a certain amount of difficulty in the lubrication of machinery which may be more or less exposed to atmospheric temperatures and weather conditions.

To effectively counteract these latter is, in fact, one of the outstanding problems in cold weather maintenance of equipment in the handling of bulk materials in the steel plant or the rock products industry, for example, or in the operation of transportation equipment or refrigerating machinery.

It is more or less impracticable to solve this problem or, in other words, to attain the ideal in effective lubrication. Lubricating oils and greases simply will not function as they should at sub-normal temperatures of operation due to physical limitations. The outstanding of these latter is the tendency towards sluggish flow and ultimate congealment.

Importance of Base

All lubricants, however, will not behave in the same manner. It will depend entirely upon their base and the extent of their paraffine wax content.

Essentially it is this latter which causes sluggish flow and ultimate congealment, to render an oil incapable of flowing to the wearing surfaces, whether this oil be delivered as such, or as the lubricating component of a grease.

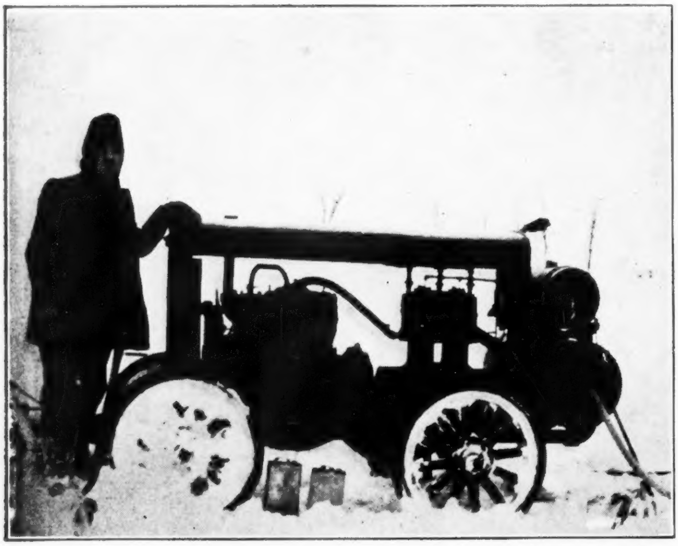
In general, lubricating oils refined from naphthenic base crudes in which the paraffine wax content is low or even negligible in many instances, will show a considerably lower pour test or temperature of congealment than those refined from paraffine base crudes, unless the latter are suitably chilled and otherwise treated for wax removal in the course of refinement.

Possibility of Ice Formation

Another important item to be considered in a discussion of cold weather lubrication will be the possibility of ice formation in certain types of lubricating systems due to freezing of water that may have gained entry through carelessness, leakage or condensation.

The presence of water in any such system will usually require investigation of mechanical or constructional details, rather than the lubricant. Today, lubricating oils of reputable manufacture can be depended upon to be water-free when received from the manufacturers. If they become subsequently so contaminated prior to actual usage, it will be advisable to check up on storage conditions. Very frequently water may gain entry in the oil house or store room due to careless exposure of an oil drum to the weather, or the activities of some laborer who may be wielding a hose too promiscuously. Good practice is never to hose out an oil house or oil room where lubricants are being stored.

Water will settle to the bottom of any lubricating system, whether the latter may involve a simple individual bearing oiler, or a complex arrangement for circulating pressure lubrication involving perhaps the wearing elements of an entire machine. If allowed to accumulate here



Courtesy of Ingersoll-Rand Co.

Fig. 1—The intensive conditions to which an air compressor may be exposed are well illustrated above. It is evident that the lubricating oil must therefore, have the lowest possible pour test if it is to function effectively.

and subsequently freeze, should operating temperatures drop sufficiently, the resultant ice formations might very easily impair or even stop the flow of oil to the bearing elements. The more detailed troubles would include damage to oil pumps or strainers where installed, broken connections, scored or even burned out bearings and a decided possibility of reduced production during the interim of subsequent repair.

An instance of how serious water accumulation may become is brought to mind by an experience with a fractured crank-case in an automobile engine, which involved considerable bearing trouble due to lack of oil circulation.

In even a sight feed oil cup or compression grease cup, water may be objectionable, and should be guarded against. The glass body of the former, or the bulls-eye indicator attachment might easily be broken if water should gain entry and then freeze, especially while such a lubricator is shut off.

In operation, water would settle from either of the above devices to the bottom of the adjacent bearing to perhaps cause sludge formation in the oil in event of oxidation at higher temperatures, and most certainly clogged oil ducts or grooves if the temperatures become low enough to cause inert or even sluggish deposits of gummy matter.

Water will also tend to wash off the lubricating film from any wearing surfaces with which it comes in contact. It is for this reason that compounded lubricants such as mineral oils containing more or less animal oil or soap in compound are recommended for the lubrication of equipment such as the rock drill where operating with water. The compound in such lubricants brings about emulsification intentionally. The type of emulsion, however, is adhesive, resistant to the washing off action of water and has the least tendency to cause gummy deposits even at low temperatures.

Development of Gummy Deposits

These latter may be regarded as another decidedly potential problem in this matter of cold weather lubrication. As a rule, however, they will only be abnormal in a circulating oiling system, or where improperly compounded greases are used.

In this connection a word as to the tendency of certain lubricants to become oxidized or altered from a chemical viewpoint will be of interest. Normally, such reactions occur at higher operating temperatures. As a result, where any machine has been running during warm weather, or in an atmosphere of radiated heat, the oil in some of its bearings or lubricating systems may have become oxidized to a certain extent. The result of such oxidation will very frequently be the formation of more or less sludge. This when agitated with water will in turn tend to form an emulsion. This may or may not be a detriment, however, dependent upon the type and construction of the wearing elements, the lubricating system and the subsequent operating temperature.

If allowed to remain in service during cold weather, or otherwise exposed to low temperatures, such sludges may become so sluggish along with the remainder of the oil as to materially impair lubrication. It has already been stated that oil ducts or grooves may become clogged under such conditions. In addition the lubricating ability of the oil as a whole may be reduced to a serious extent. This will be especially true if the oil has not been very carefully refined.

In this regard it is interesting to know that the more highly refined an oil may be, the lower will be the tendency towards admixture with water. As a result the more effectively should it resist sludge formation, the development

of non-lubricating deposits, and if of the proper base from a petroleum point of view, any marked tendency towards congealment at lower operating temperatures.

POUR TEST

The fact that the pour test is one of the most important characteristics of any oil which is to be used for the lubrication of machinery in cold weather renders a brief description advisable due to the confusion that may frequently arise in this regard, and the methods of test which are employed.

Take the so-called "cold test" for example. This has been regarded variously as that temperature at which an oil loses its fluidity, or the temperature at which solid matter commences to separate. The fact that this latter pertains directly to paraffine base oils, renders this term more or less irrelevant in respect to naphthenic or mixed base lubricants. Yet it is these latter which are most directly applicable to cold weather lubrication.

In the case of paraffine base oils the "cloud test" as generally known today, is that temperature at which solid paraffine wax commences to crystallize out or separate from solution when the oil is chilled under the conditions specified for the method of test.

Were this test to be applied to a naphthenic base oil we would be dealing with that temperature just above which fluidity practically ceases. This temperature has with equal vagueness been variously termed the "melting point," "setting point" and "point of congealment."

Today, however, it is more generally known as the "pour test" where any other than paraffine base oils are being dealt with.

There has also been marked confusion in regard to methods of determining this temperature, and ignorance in regard to the factors which may have influence upon accurate determination. Especially is this true in regard to the preparation of the sample for test.

The effect of cold upon lubricating oils is not the same as upon simple fluids such as water, alcohol, glycerine, benzine, etc. The latter have fixed and accurately ascertainable freezing points at which a complete change from the liquid to the solid state takes place, but lubricating oils which are mixtures of hydro-carbons of various melting points or freezing points behave like solutions, and frequently deposit some portion of their constituents before the whole mixture solidifies.

Interesting phenomena which can only be explained by changes in the inner or molecular structures, are observed in the pour test of many lubricating oils. If, for example, we take the pour test of an oil without previous heating and then take the pour test of the same oil after heating to 120 degrees Fahr., after allowing it to cool to the same temperature as the first, the oil which is heated solidifies at a considerably higher temperature and the influence from pre-heating seems to be effective for a considerable

Courtesy of Carr Fastener Co.

Fig. 2—In aviation it is also decidedly essential to use lubricants which will not congeal prematurely under low temperature conditions. In the above illustration grease is applied to certain of the wearing elements by a hand pressure gun.

time, at least for 24 hours. Heating to temperatures below 90 degrees Fahr. apparently has no influence.

Another factor which has an effect on the test is stirring the oil while cooling to determine the pour test. In case an oil is stirred it solidifies at a lower temperature than when held stationary. This may be explained on the assumption that the movement of the oil destroys the formation of a fine network of microscopic particles of paraffine or asphaltic bodies which are separating out.

This segregation gives the oil a certain support and thereby facilitates solidification. In an analogous way this explanation may apply to the influence of pre-heating; the waxy or asphaltic particles are probably transformed by warming, into a very strongly dispersed state from which it is possible to form a finer and thicker network than in the oil which has not been heated.

Numerous tests have been devised to determine the pour test of lubricating oils each of which gives various and sundry results in the hands of different operators, due not only to

ambiguity and lack of conciseness of the description of apparatus and method, but also in the application of the methods to oils for which they are adaptable.

Committee D-2 of the American Society for Testing Materials have taken considerable pains to work out a standard method for this determination. This method, while not new in principle, is more complete in detail than any previously published. It includes a precise definition of "cloud test" and "pour test" and classifies the oils in which each or both are applicable. Attention is therefore called to the report of this committee in event of the desire to study this matter of pour test in greater detail.

Courtesy of Ingersoll-Rand Co.

Fig. 3—The operation of pneumatic tools in cold weather also calls for the most careful attention to the pour test and viscosity characteristics of lubricants. The above illustrates a rock drill operating under conditions which might easily lead to serious wear if the oil, for example, were not able to reach all the bearings.

THE VISCOSITY

In connection with this matter of cold weather lubrication, the viscosity is also a matter of importance.

Certain machinery, such as air tools of the valveless type, for example, as are extensively used in the stone cutting trade, etc., or refrigerating compressors, will function best on a light viscosity oil of approximately 100 to 200 seconds Saybolt at 100 degrees Fahr.

On the other hand, in the materials handling field, hoists involving gear reductions will require products of approximately 115 seconds Saybolt viscosity at 210 degrees Fahr. with as low a pour test as practicable.

The above stated viscosities practically express the outside limits for low temperature operation; and yet abnormal conditions may frequently require a justifiable departure from these limits.

For example, where air tools operate in extremely cold climates, 100 seconds Saybolt viscosity might even be too high to insure adequate fluidity, it being advisable to select a naphthenic base oil of approximately 70 seconds viscosity for cylinder and valve lubrication.

For the information of those not fully conversant with this term "viscosity," it is well to state that viscosity is that inherent property by virtue of which the flow of liquids is retarded. It is therefore possessed by all oils, in varying degrees. In effect it is the resistance offered by the particles or molecules of a liquid in sliding past each other.

It is customary to measure viscosity by taking the time required for a certain quantity of the liquid in question to flow through an orifice of standard size under standard temperature conditions. The Saybolt universal viscosimeter has been adopted for this purpose by The American Society for Testing Materials.

In the oil industry it constitutes the measurement of the number of seconds required for 60 cu. cm. of oil to flow through the orifice at the standard temperature. For lighter products, such as engine and machine oil, this is usually 100 degrees Fahr. For heavier oils, such as gear compounds and steam cylinder oils, 210 degrees Fahr. is commonly used. Therefore, when an oil is referred to as having a Saybolt viscosity of 100 seconds at 100 degrees Fahr. it implies that 100 seconds will be required for 60 cu. cm. to flow through the standard Saybolt viscosimeter at 100 degrees Fahr.

Viscosity varies inversely with temperature. That is, the higher the latter, the more fluid will the average lubricant become. Under controllable conditions this is an asset, for it may permit of the one lubricant being used to serve a number of points of varying external temperature, provided the size of the wearing elements and the pressure exerted are taken into account when the lubricant is originally selected.

What "Operating Viscosity" Means

Where there is possibility of temperature varying, however, the "operating viscosity," or the body of the lubricant under actual working conditions within bearing clearances, for example, may be such as to preclude effective lubrication to a marked degree. If too heavy

it will impose more or less drag, resulting not only in added power consumption, but also in higher bearing temperatures due to internal friction. On the other hand, if this viscosity is too low, solid or metallic friction may occur, also to the detriment of the power bill, but more especially will the bearing surfaces probably suffer from increased wear. In consequence, there is a direct tie-up between power consumption, friction and temperature.

Typical Instances of Low Temperature Operation

To more clearly illustrate the requirements which low temperature operation will impose upon lubricants in general, it will be interesting to discuss the conditions in certain of the more typical industries where low temperatures must frequently be met with over considerable periods of time.

EXCAVATING AND BULK MATERIALS HANDLING MACHINERY

Machinery as used by the construction engineer and contractor is subject to probably as severe service and operates under as difficult and injurious conditions as any mechanical equipment.

Exposure to cold weather and frequent contact with ice, snow, mud, dust and such abrasive and corrosive materials as ashes, cinders and ore, etc., subject the working parts of the average crane, power shovel, dragline excavator or dredge to a rate of depreciation that is oftentimes far above normal.

To counteract the injurious effects of such exposure, machinery of this type is rigid in design and is constructed to withstand wear and tear to the highest extent.

It stands to reason, however, that regardless of mechanical features or the chemical nature of the metals used, wear will occur relatively rapidly unless a protective element in the form of a lubricant is effectively applied to all wearing parts. Therefore, lubrication in the field of construction engineering is a paramount feature.

Steam Cylinder Lubrication

One of the most important details is the lubrication of steam cylinders. In any of the above machines which are steam driven, the existing conditions and methods of operation will be such that if any but a high grade, properly compounded lubricant is used, the cylinders may suffer accordingly.

At best the steam used on such machines will, in general, be of comparatively low pressure (ranging from 100 to 150 lbs.) and will have quite an extensive moisture content. Although steam is taken from the highest part of the boiler, it will frequently be relatively wet when it enters the header. This will be all the more true in cold weather.

Furthermore, line condensation and moisture content will be high between the boiler and engines, with a corresponding decrease in pressure, due to the fact that steam pipes are often not kept covered to any great extent, and the engines are frequently subject to intermittent operation.

As a result there will almost always be an accumulation of water above the throttle valves, prior to starting the engines, depending in amount upon the length of time the latter have been stopped.

If the cylinders are not covered with a tenacious film of properly compounded lubricant, the admission of these slugs of water will tend to wash the lubricant from the wearing surfaces, and for the next few strokes insufficient lubrication will be possible and scoring and abnormal wear may occur.

The constant repetition of the above will not take long to produce compression losses and inefficient operation of the entire machine due to steam leakage past the piston rings.

Courtesy of Harnischfeger Sales Corp.

Fig. 4—In many localities excavation must be carried out regardless of weather conditions. The trenching machine must therefore be given careful attention from a lubrication point of view. As a rule a great number of the bearings and gears, and practically all wire ropes are exposed to the elements, and subject to washing off of lubricants by rain or melted snow.

Groaning of the engines or rattling of the valves on their seats may also occur in extreme cases.

It can therefore be appreciated that the problem is to select and use a grade of cylinder oil which contains a sufficient amount of high grade animal or fixed oil to promote the forma-

tion of an extremely tenacious film of emulsified lubricant, which will adequately resist the washing action of any water that may be present.

The base of this lubricant should be a medium viscosity, highly adhesive, steam refined cylinder stock. For this purpose a comparatively high compound cylinder oil of about 130 seconds Saybolt viscosity at 210 degrees Fahr. has proven to be most satisfactory.

To efficiently lubricate such steam cylinders the oil should be delivered by a positive feed lubricator, preferably of the mechanical force feed type, via suitable atomizers. Hydrostatic lubricators can be used where the engines are to operate continually, but the usual intermittent service involved would either require constant closing and opening by the operator or else a waste of oil would follow if the lubricator were left in service while the engines were stopped. The location of the oil pipes and atomizers in the steam lines is also important. These points should be from three to six feet back from the throttle valves.

In cases where a steam thrusting or crowding engine is located on the boom in certain types of these machines, the oil line often enters the steam pipe much further back from the throttle, with the result that in event of steam leaks at the ball or swing joint there will be considerable loss of oil as well, with subsequent insufficient lubrication unless the leak is stopped.

Tractor Elements

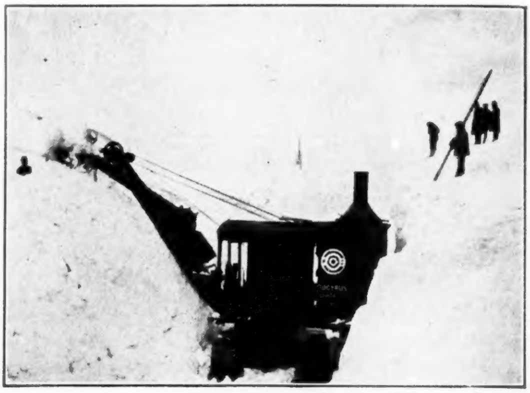
Where excavating machines, etc., are equipped with caterpillar tractors the lubrication of link-pins and rollers is also an important factor, in order to insure against excessive friction losses and power consumption, especially where they must operate in ice or snow. Automatic lubrication is an excellent idea on such parts, the lubricant being furnished from internal reservoirs located in the treads and rollers. For this service a relatively heavy straight mineral lubricant having a viscosity of about 200 seconds Saybolt at 210 degrees Fahr. is adaptable.

Other Wearing Parts

The lubrication of other wearing parts on the average excavating or materials handling machine can be well taken care of by means of a medium viscosity straight mineral oil or a high grade grease of adequate consistency to insure positive flow to the bearings at all times.

Many builders recommend grease lubrication and accordingly equip their machines with pressure grease fittings. Grease for this purpose should be free of acid or alkali and should contain no filler such as talc or asbestos, which would tend to clog the oil grooves.

External lubrication on such machinery, whatever its nature, is necessarily a difficult proposition, and enough dirt, dust and abrasive matter will work its way into the bearings without the addition of any more in the form of improperly compounded greases.



Courtesy of Bucyrus Company

Fig. 5—An interesting illustration of a steam shovel operating practically below grade in snow. As a means of handling materials the steam shovel is ideal but it is evident that its exposed wearing elements must be properly protected by oils and greases which will maintain adequate lubricating films.

When engine bearings, etc., are lubricated with oil, the viscosity of the latter should be in the neighborhood of 300 seconds to 500 seconds Saybolt at 100 degrees Fahr. For electric motor bearings, however, a lighter oil will be best, ranging from 180 seconds to 200 seconds viscosity.

WIRE ROPE LUBRICATION

On equipment involving wire rope the latter must also be given the most careful attention in cold weather in order to insure its preservation and continued efficient operation.

This is one of the most important factors in any plant where materials in bulk, such as ore, coke or coal are to be handled. For the ultimate efficiency of operation is, to a large extent, dependent upon the condition of the cables or wire ropes. We can easily realize that a rope with one or two broken strands due to rusting or wear traceable to improper lubrication, may not only cause a tie-up of the entire machine if such strands interfere with the operation of sheaves, or other companion cables, but may also present a distinct hazard. Any wire rope in such condition is just that much weaker and less capable of handling the imposed loads.

Visualize how important this might be in the case of a car unloading device, for example, where loads approximating 100 tons are frequently handled.

The Occurrence of Friction

It is not enough to assume that because such ropes come from the manufacturers in a lubricated state, being in general wound on an

oil-saturated core, that further lubrication is unnecessary. Under operation there is constant friction and wear between the strands, and a tendency to squeeze out any contained lubricant, especially when the ropes pass over sheaves or around drums. The renewal of this product is, therefore, an absolute necessity.

The matter of friction between the strands of a wire rope is essentially the same as friction between a bearing and shaft. Overheating and abnormal wear will practically always result, to reduce the load carrying capacity and increase the amount of power consumed in operation. This can only be overcome by effective lubrication, brought about by the proper application of a suitably prepared wire rope compound, which will be capable of not only penetrating to the innermost strands and core of the rope, but also sufficiently adhesive and viscous to resist being prematurely squeezed out or washed off by rain or melting snow.

Character of Wire Rope Lubricants

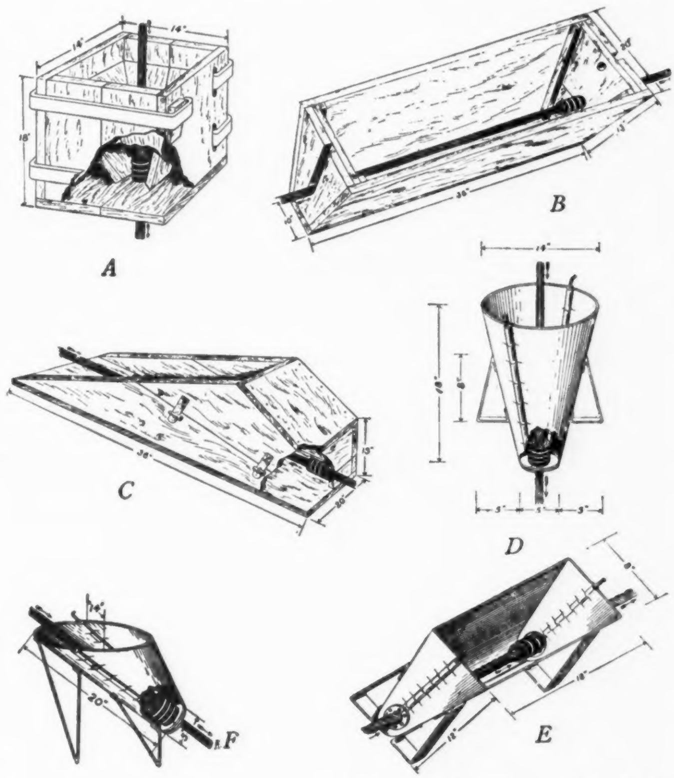
Essentially a wire rope lubricant, in addition to the properties mentioned above, must not tend to cake, gum or ball up, especially if contaminated with an excess of dust, dirt or metallic particles. This, of course, directly involves the viscosity or relative fluidity of the product. In fact, viscosity of such products is the essential characteristic involved in purchasing. It should not, however, be assumed as being the chief guide as to the actual suitability of a wire rope lubricant.

In this regard the ability of the latter to function, penetrate and stick under actual operating conditions, is of outstanding importance. In consequence such products should not be purchased haphazardly, nor on a price basis alone. The potential difficulties that might result are too serious.

According to the operating temperatures that may be involved and the possibility of the presence of an excess of water, the viscosity of a wire rope lubricant should range from 600 to 1000 seconds Saybolt at 210 degrees Fahr.

Wire rope lubricants to meet the aforesaid requirements should, in general, be straight mineral petroleum products, devoid of fillers or thickening mediums. In other words, whatever the viscosity, it should be an inherent property of the lubricant, not an artificial characteristic which cannot be depended upon.

It is for this reason that greases or soap thickened mineral oils are relatively unsuited to wire rope lubrication. To attain the requisite body a comparatively high percentage of soap would be necessary. Soap, of course, serves as the carrying medium for the oil, but it has relatively no lubricating value; therefore, this property, in the resultant product, is decreased to a marked extent. Furthermore, the adhesive characteristic of greases is low. In consequence such products will not, in general, meet the requirements of wire rope lubrication.



From Texaco Crater Compound Handbook.

Fig. 6—Constructional details of typical wire rope lubricating and treating boxes. A, B and C are of wooden construction. A, to treat a vertical rope; B, a horizontal rope; and C, a rope located at an angle. D, E and F are similar boxes of metal construction.

Application of Wire Rope Lubricants

As a general rule wire rope lubricants, by virtue of their viscosity and inertness, must be applied in heated condition. To merely attempt to daub or paint a rope with such a product would be relatively useless. Even though the surface might be more or less coated, the possibility of penetration occurring to any extent would be remote. We must realize that this latter is the secret of effective wire rope lubrication. The amount of wear

occurring between the exterior of such a rope and the sheaves is not as marked as that which occurs between adjacent strands when the rope is flexed or bent as in passing over sheaves or hoisting drums.

A very satisfactory method of treating wire ropes is to use a form of box as illustrated in Fig. 6, according to the angle of the rope in question. Such a box can be readily built in the average plant, with suitable provision for rendering it sufficiently tight to prevent the lubricant from leaking out even when reduced in viscosity by heating. The slow passage of the rope through such a bath of heated compound will insure that not only will the surface be coated, but also that the requisite penetration takes place to the inner strands.

Further working of the rope over the sheaves before the lubricant has time to cool entirely will tend to aid in bringing about the maximum of penetration.

Courtesy of Link-Belt Co.

Fig. 7—It is also oftentimes essential to operate conveyors throughout the winter even though they may be exposed to rain and snow. The rollers will be the essential wearing elements which require lubricants, but they must be given every attention; otherwise abnormal friction and wear may result.

ROCK PRODUCTS AND COAL TIPPLE MACHINERY

In the production of rock products and coal the problem of cold weather lubrication may frequently become aggravating, especially in view of the fact that much of the machinery involved is so rugged as to deceive the operators in regard to the actual amount of wear which may occur if friction is not effectively reduced.

The handling of such products is at best a difficult job and one conducive to a good deal of wear and tear. In part the effects of this latter on exposed wearing elements, such as bearings, gear teeth and chain links have been discussed in a previous chapter in connection with the lubrication of excavating and bulk materials handling machinery. Essentially such machinery may be regarded as production equipment.

In turn the so-called refining equipment must be treated as well, for the crusher, breaker or screen, for example, will frequently be subjected to quite as intensive service as the crane, power shovel or other digging machine in cold weather.

The coal tipple is rarely heated, though it is usually under adequate cover. In the stone quarry or gravel pit, on the other hand, even covering may be an absent luxury. And yet graded coal, fine stone or building sand must be produced, almost regardless of the weather or temperature. So gear teeth and bearings may very easily present a problem in lubrication. Quite often the former are not even guarded.

Jaw Crushers and Breakers

To enable the clearest understanding of the several factors which should be considered in cold weather lubrication, it will be well to discuss the equipment involved in an individual manner.

Lubrication is essentially confined to the bearings of the pitman and eccentric shaft. The former carry the pitman or heavy steel casting which oscillates with its bearing as the point of suspension, to bring about the requisite degree of crushing. As a rule the pitman bearing is water cooled; in addition, in certain larger crushers it is relieved of much of the weight by the use of links and coiled springs, for the potential friction involved is considerable.

As a result, lubrication of the pitman bearing is of decided importance. Grease is usually the most generally adaptable lubricant, being applied to the bearing either by means of pressure lubricators or via reservoirs equipped with wool waste or some other form of pad retainer to insure positive lubrication without undue loss.

Where pressure lubrication is employed a light solid grease will usually be most adaptable. The use of wool waste or pad lubrication, however, will require a thinner grease, relatively fluid in consistency, in order to enable proper penetration of the wool. In both instances the lubricant must be capable of reaching the lower wearing surfaces where pressures and friction will be the greatest irrespective of the operating

temperature. To more safely insure this certain builders provide for delivery of grease (under pressure) to both the top and bottom of the bearings.

Eccentric bearings likewise require positive lubrication with a suitable grade of grease. Unless the weight of the pitman is more or less balanced by springs, etc., its weight will be exerted upon the eccentric shaft bearings, with the probable result that the lubricant will be unable to penetrate and maintain the requisite friction-reducing film between the shaft and bearings.

The construction of the crusher must therefore always be taken into consideration; where springs and links are used to balance the pitman, reservoir pad lubrication using a medium fluid, low pour test grease will probably work out satisfactorily.

Where the weight of the pitman is exerted on the eccentric bearings, as well as on its own supports, pressure lubrication with a heavier grease will be more positive.

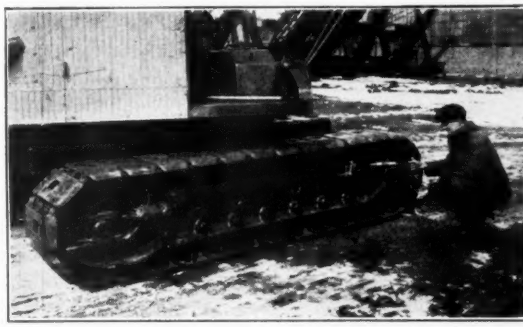
Gyratory Crushers

In the modern gyratory the matter of eccentric, gear, counter shaft and anti-friction bearing lubrication are most important. Automatic lubrication whereby the oil is circulated under pressure throughout the lower mechanisms is becoming practically standard on all such equipment due to the absolute necessity for continued and dependable maintenance of a sufficient flow of oil to withstand the pressures involved.

This is brought about by means of a suitable oil pump which is located at the bottom of the crusher either within or adjacent to the oil reservoir or chamber in the bottom plate. An ample supply of oil is contained in the system, which as a rule includes a suitable filter or strainer through which the oil passes at each circulation. This, together with the general dust-proof construction of the modern gyratory insures against the entry and circulation of an excess of dust through the system. As a result, all the lower wearing parts are served with a flood of clean oil throughout the period of operation of the gyratory crusher, for by virtue of the nature of the design and construction the oil pump starts simultaneously with the latter, operating at a speed commensurate with the rate of crushing.

In cold weather it will always be advisable to resort to an oil of comparatively low viscosity, especially if there is no provision (in the form of heating coils) in the system for heating the oil prior to starting, or during operation. Usually a viscosity of from 500 to 750 seconds Saybolt at 100 degrees Fahr. will be best, according to the necessity for lower pour test and greater fluidity, especially on starting.

The top bearings, suspension and wearing rings within the dust or spider cap at the top of the main shaft of the average gyratory crusher will also require considerable care in lubrication. Essentially a product must be chosen which will not run prematurely through the



Courtesy of Carr Fastener Co.

Fig. 8—Illustrating the lubrication of the tractor elements of an Erie shovel. The application of grease by means of pressure as above is excellent insurance against accumulation of abnormal amounts of foreign matter within clearance spaces, as well as being a positive means of maintaining an adequate lubricating film.

bearings, at higher temperatures, to perhaps leave their surfaces susceptible to excessive friction and wear, and yet it must not become too heavy in cold weather. As a general rule crusher oil will be best for this purpose provided that it has a sufficiently low pour test.

To facilitate the retention of the oil, the space within the cap can be packed with a pad of wool waste saturated in the lubricant. This should last for several weeks, provided that a small quantity of fresh oil is added every day or two via the oil hole in the cap.

Ball, Tube and Rod Mills, Etc.

The above equipment, where supported by horizontal shafts, will frequently be difficult to lubricate, because of the great weight carried by the bearings and the fine dust which will always find its way into the clearance spaces. Every possible precaution is taken to keep this dust out of the bearings, but it is practically impossible to attain this ideal, with the result that foreign matter of this nature is frequently the cause of their rapid destruction.

The main shaft bearings are relatively large so that the unit loads are not excessive, but in spite of this it is necessary to use a lubricant possessing considerable body even in cold weather in order to prevent undue frictional heat. Fortunately, such mills revolve comparatively slowly and there is no objection to a heavy lubricant from the viewpoint of speed. As a rule, a grease of medium consistency will be the most suitable lubricant for these bear-

ings, provided its oil content will insure adequate fluidity.

Because of the speed at which it revolves, the pinion shaft on such mills is frequently carried in ring-oiled bearings. The most suitable lubricant for these in cold weather is an engine or machine oil of about 200 seconds Saybolt viscosity at 100 degrees Fahr.

For the gears of such mills the most satisfactory lubricant will usually be one with adequate body or viscosity to prevent metallic contact under heavy loads, and resist the drying action of dust. As a rule a straight mineral lubricant of approximately 1000 seconds Saybolt viscosity at 210 degrees Fahr. will best serve this purpose, unless temperatures fall too far, when it may be advisable to drop the viscosity to perhaps 200 seconds Saybolt.

Crushing Rolls

On such equipment gearing will be the essential parts which may involve difficulty from a lubrication point of view in cold weather. Such parts by virtue of their usually exposed nature will function best if treated at periodic intervals with a fairly heavy-bodied gear lubricant. This must not be too heavy nor applied in excess, otherwise there will be a tendency of dust being accumulated, the resultant paste or scale of dust-impregnated lubricant being thrown off during subsequent operation.

Rotary Type Screens

The mechanism at the driving end of the average rotary screen involves the most difficulty from a lubricating point of view, especially in regard to the gears. These latter will, as a rule, operate exposed with their lubricants subjected to contamination by dust, dirt and probably moisture.

These conditions would, of course, also affect the bearings to a certain extent, although the housings, if properly designed and installed, would prevent at least the entry of an excessive amount of dust and dirt or water. As a rule these are plain babbitted bearings with provision for grease lubrication.

Under the prevalent operating conditions, grease is probably a better lubricant than oil due to its ability to maintain a more effective seal against entry of abrasive foreign matter. It must be a product insoluble in water, however, due to the possibility of its having to withstand the washing action of rain, or any water used during screening. As a rule, a grease of medium body or consistency with a low pour test oil content to insure adequate fluidity at low temperatures will be best suited to these conditions, and capable of ready application by means of some form of compression cup or other pressure lubricator.

For the gears (including girth gears wherever installed) a lubricant must be used which will not only form a protective film to counteract the abrasive effect of dust, dirt, etc., but also will function irrespective of temperature, moisture or weather conditions. A straight

Courtesy of Baker-Raulang Co.

Fig. 9—The electric industrial truck lends itself to many uses. One of its essential duties is oftentimes to act as a snow plow. This will, of course, impose a considerable load upon electric motor bearing and rear axle gear lubricants by virtue of the fact that they must not only be able to function effectively at higher temperatures within buildings but also must have adequate fluidity to insure against congealment when the truck must be used out of doors at probably much lower temperatures.

mineral residual product will give the most satisfactory results. Usually a viscosity of approximately 200 seconds Saybolt at 210 degrees Fahr. will adequately serve the purpose in cold weather.

Vibrating Screens

In the case of vibrating screens the vibratory mechanism is somewhat more intricate than the driving gears and bearings of a rotary screen. It may, therefore, develop more potential difficulties in regard to lubrication. Grease has been found to be very satisfactory on such equipment, affording the requisite protection to the various bearings by preventing the entry of dust and dirt. As a rule some form of compression or pressure grease lubricating device should be used to insure as nearly positive lubrication as possible. In such equipment a medium bodied grease compounded with a low pour test mineral oil should meet average cold weather requirements.

REFRIGERATING MACHINERY

Refrigeration, includes both the manufacture of ice and the cooling of air in cold storage systems. The former, involving water as it does, presents the possibility of dampness, and where ice is allowed to melt, the matter of sanitation and water removal. The latter, on

the other hand, is relatively dry, with little or no moisture involved.

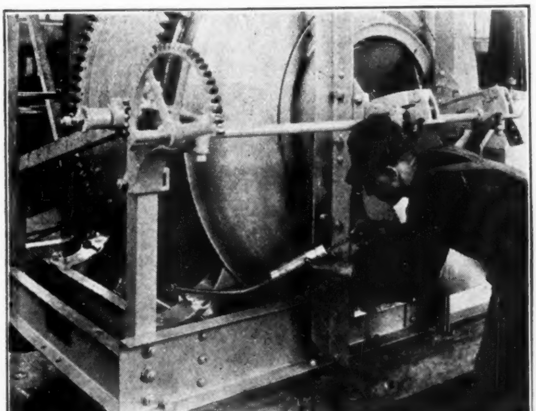
Importance of Lubrication

Refrigerating machine lubrication is an important factor. Oil in any part of a cooling system will tend to reduce refrigerating efficiency due to its becoming so sluggish under the low temperatures involved as to form an interior lining in the expansion coils and materially affect the heat transfer.

Lubrication of refrigerating machinery is exceptional in that we must consider the action and effects of the lubricants upon parts not requiring lubrication, as well as upon the actual wearing surfaces. As a result, considerable care and judgment must be used in selecting the lubricants.

For example, where piston rings are not sufficiently tight, if the crank-case contains too much oil, or agitation is too violent, the excess which naturally will reach the cylinder walls will tend to work past the rings. This is often termed oil pumping.

Not only is it wasteful, but especially in an ammonia compression system will it be a detriment, for oil in the refrigerating lines will impose an added load on the oil separator. Furthermore, if by chance the oil is not of sufficiently low pour test there will be a possibility of its congealment within the system, reducing refrigeration to a marked degree.



Courtesy of The Bassick Mfg. Co.

Fig. 10—Illustrating the means of lubricating certain of the bearings of a concrete mixer with a hand pressure grease gun. Here is also a case where the lubricant must not only be able to reach the wearing elements but also must maintain a protective film against the possible entry of ice, snow, water, dirt or other foreign matter.

Selection of Compressor Lubricants

Refrigeration machinery has been discussed in detail in past issues of LUBRICATION. The salient features involved in the selection of suitable lubricants, however, will warrant repetition in the present article, in order to round out our knowledge of the influencing factors in low temperature lubrication.

Lubricants for cold storage and refrigeration machinery must always be selected with due regard for the service involved and the operating conditions that will probably be encountered. To overlook or disregard the importance of such factors as the method of lubrication involved, the temperature in the expansion or refrigerating coils, the mechanical condition of the compressor, etc., and the location, type and efficiency of the oil separator may frequently lead to marked increase in maintenance costs and reduction in capacity.

Importance of Fluidity

Of course, the most important essential in regard to an oil for refrigerating machinery lubrication is that it shall remain fluid at the lowest temperatures to which it may be subjected during operation. These temperatures will be encountered in the expansion or refrigerating side of the system, or in other words, beyond the expansion valves. There are many oils, which by virtue of their base and degree of refinement, will not be able to withstand lower temperatures without congealing to a certain extent, depending upon the amount of wax that may be contained.

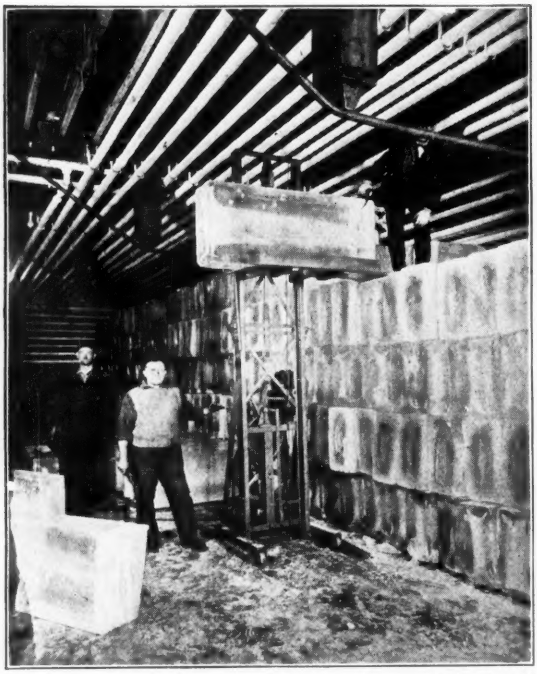
Congealment, of course, will mean that a film of oil will be deposited on the inner surfaces of the refrigerating piping, to form more or less of an insulating medium which will prevent proper abstraction of heat from the compartment or medium which is to be cooled. If this is allowed to continue it is evident that the refrigerating capacity of the system will be reduced and ultimately it will be necessary to clean out these congealed oil deposits.

An oil to be suited to this class of service should, therefore, have a pour test sufficiently low to insure continued fluidity at the lowest temperatures prevalent in the evaporating side of the system. It should not congeal on the inner surface of the cooling coil, and there should be sufficient viscosity throughout the range of operating temperatures to enable it to serve at all times as an effective lubricant for the moving parts as well as an adequate seal for the piston rings and compressor valves.

Type of Oil to Use

For such service a straight mineral filtered oil having a viscosity of about 100 seconds Saybolt at 100 degrees Fahr. will be necessary where the temperature of the gas to the compressor is below 0 degrees Fahr. Above this temperature, however, an oil of somewhat higher viscosity, i.e., 200 to 300 seconds Saybolt, will often give more satisfactory results.

The purest grade of straight distilled mineral oil obtainable is always advisable in order that the above requirements will be adequately met. Oils of this nature will have a sufficient range of physical properties to lubricate compressors effectively under all normal operating conditions.



Courtesy of Economy Engineering Co.

Fig. 11—In the refrigerating plant the handling of ice is a decidedly important matter. The lift truck has proven itself adaptable to this purpose. Here again, however, the low temperatures involved will require that every attention be given to the choice of lubricants for the wearing elements.

Water an Objection

Relative to this matter of possible congealment, consideration must also be given to water. It is essential that the oil at all times be practically free from water, otherwise this will freeze if carried over to the refrigerator coils, in which case it would probably remain in the system and result in a certain decrease in evaporative efficiency.

It is therefore necessary for the operator to use the utmost care in placing oil cans beneath snow-covered suction pipes, etc., or anywhere else where moisture might splash or drip into the contents. An excess of water can readily cause so much trouble in the evaporator coils as to necessitate shut down of the plant until this is corrected.

Relation of Viscosity

When enclosed crank-case, high speed machines are involved, higher viscosity oils should be used which will stand considerable churning in the presence of the refrigerant and a certain amount of water vapor. To some extent the emulsions which may result will serve as lubrication for the cylinder wall, due to their adhesive nature. In excess, however, they will accumulate in the crank-case and tend to pass by the piston rings and into the system, where clogging may ultimately occur.

The physical condition of the valves, piston rings and stuffing boxes, must always be considered in deciding upon the viscosity of oil to use. Practically as important as its lubricating properties will be the seal and compression-forming ability. If the cylinder wall and moving parts are in first-class condition, a straight mineral oil of approximately 200 to 300 seconds Saybolt viscosity at 100 degrees Fahr. will be suitable.

Function of the Oil Separator

In view of the fact that an excessive amount of lubricant fed to the compressor will tend to impose a heavy load upon the oil separator, the actual function of the latter should be studied. Actually it serves to remove any particles of oil from the refrigerant while it is in gaseous form, after it has left the compressor. The larger the oil particles, of course, the more efficient will be the separator. Therefore, it should be located at a sufficient distance away from the compressor to permit of adequate precipitation, of the oil within the gas. The capacity of any separator should be ample so that the velocity of the gas passing through will not be too high.

Atomization of the lubricant will practically always take place to a certain extent by virtue of the heat of compression which is prevalent, regardless of how high the flash point may be. This oil vapor will, therefore, tend to pass into the system with the refrigerant to condense and remain in the colder parts unless it is effectively removed before it enters the condenser.

In consequence the separator should be located as close to the condenser and as far away from the compressor as possible. It is always advisable that it should be of sufficient size to allow of ample reduction in the velocity of the gas in order to permit of effective separation. A smaller separator located some distance from the compressor may often prove more effective than a large separator located nearby.

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